Assessing 1D RT Models: ICRCCM in Review and Plans for BBHRP / CIRC

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- a brief review of ICRCCM
- CIRC and ARM's BBHRP
- expanding on model verification / validation

  - bias errors vs. random errors

  - ramifications for host models

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ICRCCM in Review

- ICRCCM (InterComparison of Radiation Codes for Climate Models)

- ICRCCM-I (1984 - 1991)

  - LW: Ellingson and Fouquart (1991)

    - ~60 idealized cases (mostly cloudless)

  - SW: Fouquart et al. (1991)

    - ~60 idealized cases (again, mostly cloudless)

- **Overall message**: for cloudless skies, errors can be alarmingly large

ICRCCM in Review

- ICRCCM-II (1991): SPECTRA (FIRE II)

  - Ellingson + Wiscombe (1996)

- **Overall message**: using observations to assess models can be fruitful, but it is ***HARD***... ARM program.

ICRCCM in Review

- ICRCCM-III: (GRP; Barker et al. 2003)

  - SW only (LW ???)

  - Interpretation and handling of unresolved clouds

  - CSRM domains; benchmarks set by 3D MC codes

  - cloudless and cloudy (pph and 3D)

- **Overall message**: standard assumptions are often inadequate *and* no 1D single method is adequate for all.

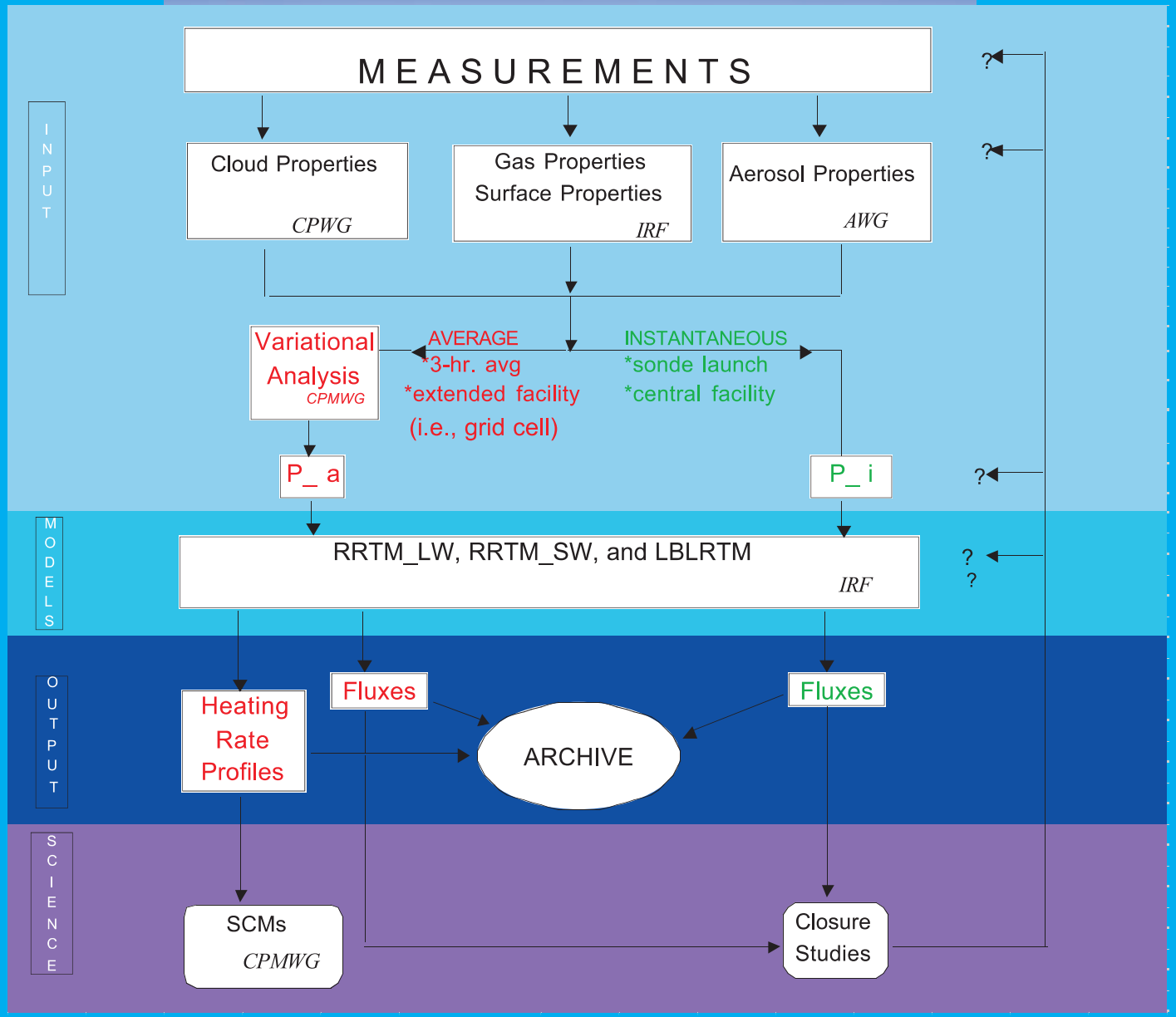
CIRC / BBHRP

- Continuous Intercomparison of Radiation Codes
- Observations used as radiative benchmarks
  - ARM observations provide input and radiative benchmarks (mainly select BBHRP cases)
  - Reference calculations (incl. HRs) are based on both LBL and LBL-tuned C-K models
- A new standard for assessing GCM-style SW and LW RT codes
- Sponsored by ARM and GRP (Endorsed?)

ARM's BBHRP

- BBHRP (Broadband Heating Rate Profile) dataset, the main driver of the project (E. Mlawer leads)
- BBHRP VAP includes observed and calculated surface and TOA radiative fluxes and input necessary for RT calculations (clouds, surface properties, atmospheric profiles, etc.)
- Cloud input from MICROBASE (M. Miller leads) based on surface observing systems (MMCR, MWR, MPL, etc.)
- Currently applied to SGP site (2000), but plans exist to expand to NSA and TWP & more years;
- Computations made with AER's SW and LW RRTMs (C-K codes)

BBHRP flowchart



Proposed cases for CIRC

- Synthetic high spectral resolution, cloudy and clear based on previous ICRCCM cases
- Observed high spectral resolution case for clear and homogeneous liquid cloud
- BBHRP cases:
  - Clear (aerosol free, aerosol-laden)
  - Homogeneous liquid cloud(s)
  - Homogeneous ice cloud(s)

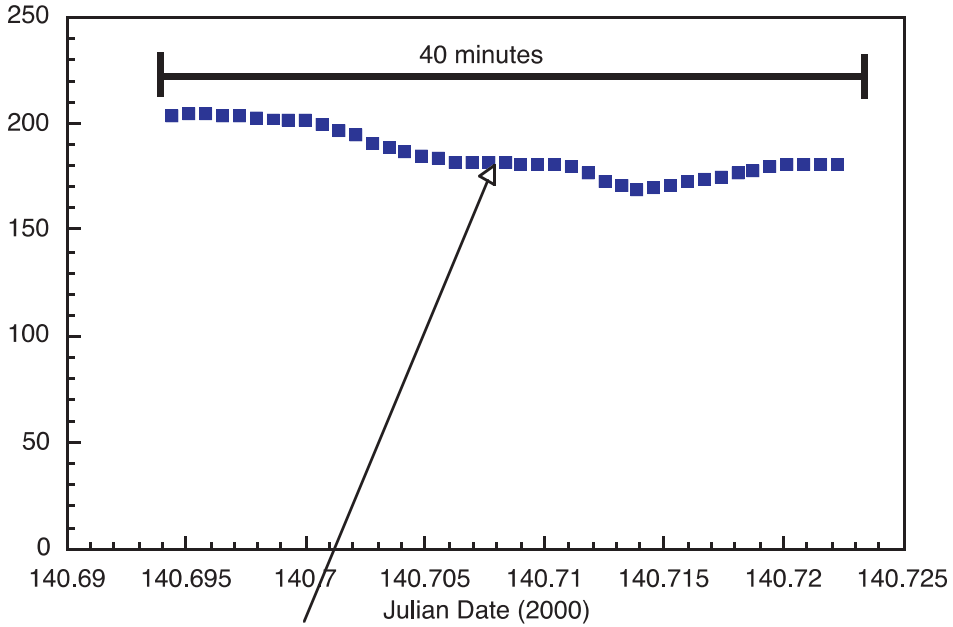
Issues

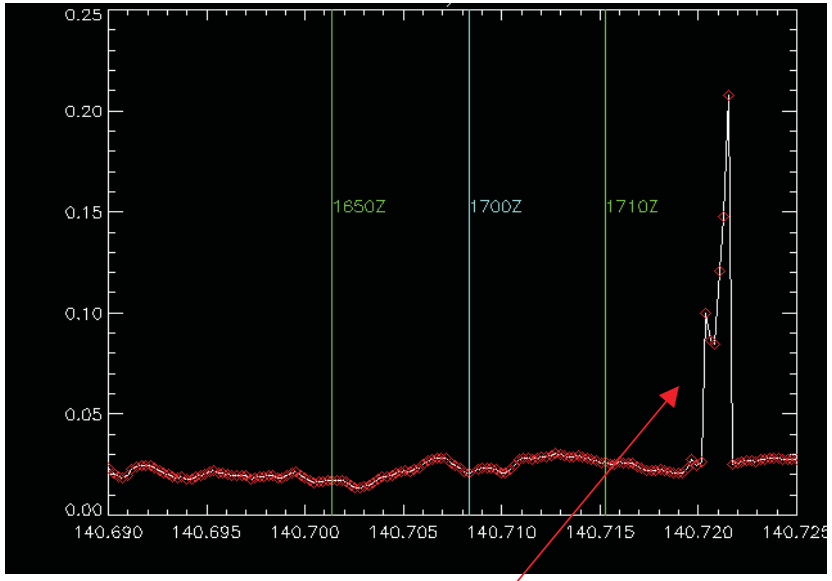
- Synthetic spectral: no problem
- Observed spectral: Cloudy (homog.) case hard to find, surface spectral obs. not always available; case of 5/19/00 SGP ARM site candidate
- BBHRP liquid: Homogeneous clouds rare; pass QC tests (incl. agreement with obs.)
- BBHRP ice: Easier to find homogeneous, but microphysical to SS property conversion uncertain; will have to use ensemble approach for cases passing QC tests

Example: The 5/19/00 case

(not part of *current* BBHRP dataset)

A good candidate case occurs ~ 1700Z at SGP:
an uncommonly stable liquid cloud

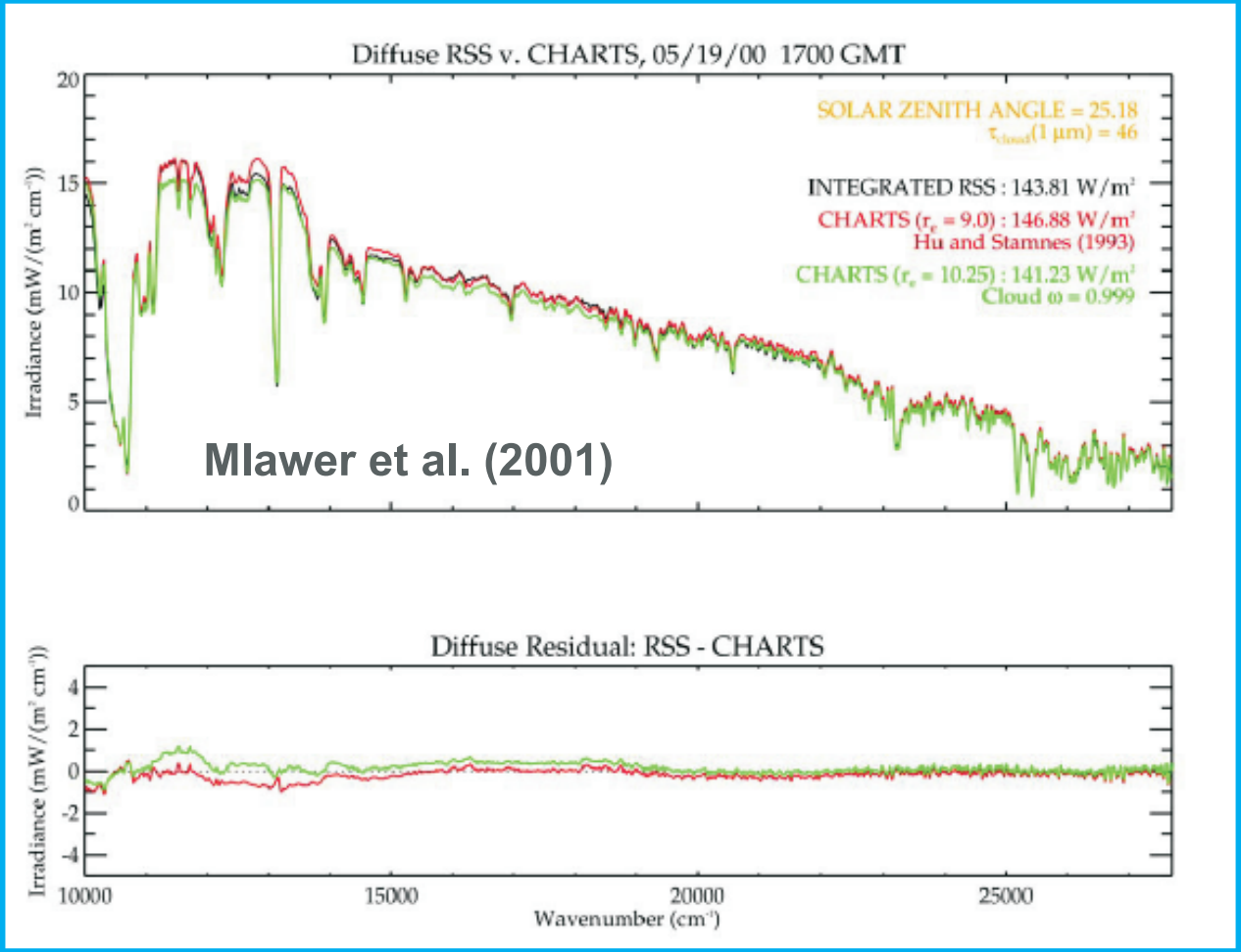




At 17:00,
5-min-stdev/5-min-avg
= 0.003

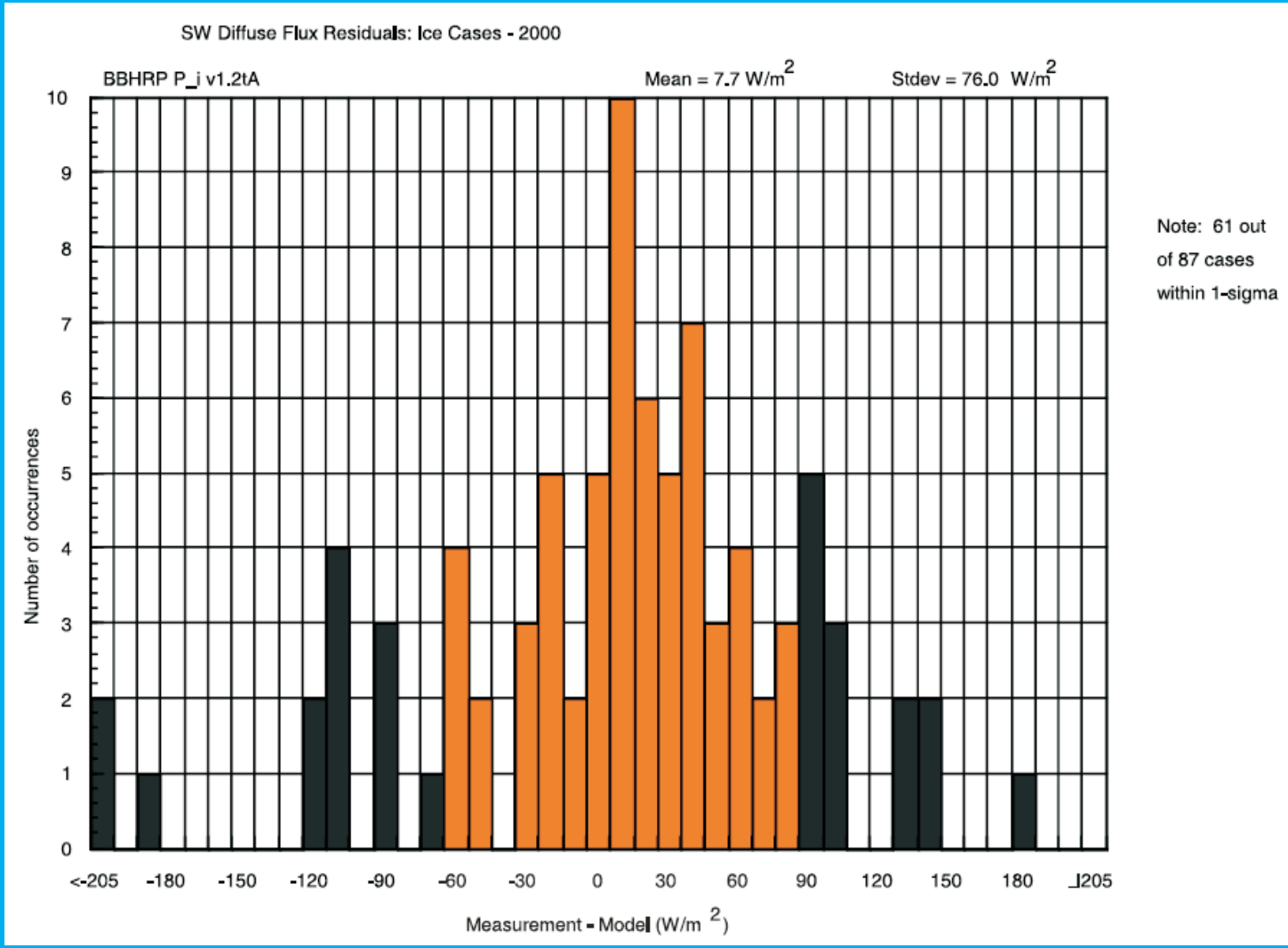
Spike caused by
anomalous instrumental
behavior -- please ignore

Example: the 5/19/00 case



Currently being revisited with MICROBASE retrievals; will redo CHARTS/LBLRTM calculations

BBHRP ice clouds



Choose all cases within 1-sigma that also pass QC (less than 61);
Observed-RRTM differences less stringent criterion than for liquid clouds

Organizational structure choices

- Open structure: Website hosts input and output, interested parties download everything they need for model assessment
- Closed (blind) structure: Only registered users can download input, submit output to CIRC organizers (within deadlines); benchmarks results unavailable; CIRC HQ performs model evaluations. Anonymous?
- Hybrid structure: Input and some output (spectral cases?) available to registered users; carrots (additional cases, participation in workshops and publications) for formal participants (must meet deadlines). Anonymous?

CIRC future and strategic goals

- B. Collins (NCAR) has suggested that CIRC cases become official IPCC-sanctioned test cases for 5th assessment (submissions due: 2009)
- Run CIRC in two cycles
  - 1st cycle according to action plan and one of the organizational structures (hybrid?)
  - If 1st cycle successful and draws attention of IPCC, adapt 2nd cycle to IPCC requirements
- Model “certification” becomes an IPCC issue
- CIRC is the successor of ICRCCM. Need formal ties (WG) within IRC?

Verification and Validation of 1D Models

- Verification
  - assess coding and parametrizations
  - e.g., gaseous transmittance, optical properties
- Validation
  - assess model assumptions (test hypotheses):
    - e.g., pph, overlap, crystal structure

Verification and Validation of 1D Models

- Validation

  - assumptions upon which models are built

    - bias *and* random errors

    - stand-alone *and* interactive

decrease solar absorption

Increase cloud albedo

Cloud-Albedo Feedback Loop

Increase Cloud Water

Increase CO_2

Increase Temperature

Increase Water Vapour

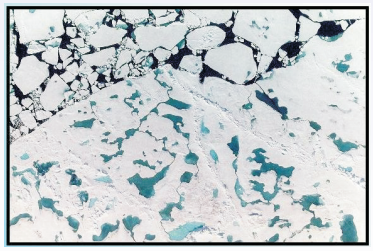
trap more IR radiation

Water Vapour Feedback Loop

Melt Surface Ice

Increase Solar Absorption

Ice-Albedo Feedback Loop



e.g., various amounts of *unbiased* noise for McICA